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The Design of Not-so-everyday Things: Designing for Emerging Experiences

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Abstract:

In this paper, we explore how emerging technologies and experiences challenge previous theories and practices to grow and adopt and, thus, address new and unique challenges, such as designing across macro-level ecosystems, new devices, and interaction models that enable user control of data in an increasingly complex digital world. We discuss these topics with respect to real and future examples, the unique challenges they present, and how academia and industry must collaborate to adapt current frameworks and develop new methods to address these challenges. This partnership will ensure both parties better understand the problem space for designing emerging experiences in today's digital economy. Further, this partnership enables scholars and practitioners to more effectively explore the solution space for designing novel products and developing advanced theories that help craft meaningful user experiences. Finally, we argue that the partnership between academia and industry can develop future talent and upskill current practitioners, which is paramount in successfully meeting the challenges inherent in the design of emerging technologies.

Keywords: User Experience, IoT, Smart and Connected Environments, Wearables, Form Factor, Interaction Method.

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1 Introduction

The Internet of things (IoT) revolution has arrived. So far, the takeover has primarily involved machine-to-machine (M2M) connectivity and industrial applications that address B2B needs. However, as the IoT continues to expand further into consumer products and experiences (Nelson & Metaxatos 2016). As these technologies enter new markets, they introduce new design and product adoption challenges. In some cases, traditional user experience (UX) design and user research (UR) practices can help address these new challenges. However, the IoT's pervasiveness intensifies the complexity of interconnected ecosystems, the wide scope of new form factors and interaction models, and new privacy and security vulnerabilities. To address these growing challenges, academic and industry partnerships must pursue new approaches to designing smart and connected systems.

2 Systems Thinking and Ecosystems

For the most part, traditional product design focuses on products' core experience and a micro ecosystem of related experiences in product families. As the IoT and emerging experiences cross the chasm into mainstream adoption, the complexity of interactions with other products and experiences expands exponentially, which creates a broader macro ecosystem. These interactions increase the system's overall complexity. In turn, that complexity makes it more difficult to identify unmet user needs and map them to a product value proposition that features and experiences back to achieve product-market fit. As with any solution, IoT products must focus on the end results and experiences that the end solution affords and not just the underlying technology that makes the solution possible (Nelson & Metaxatos, 2016). Additionally, designers have varying levels of control over their brand and experience across these interconnected products. How can designers ensure a consistent and cohesive experience when they may not have the same level of control over each product in a complex macro ecosystem?

For example, in the not-so-distant future, an individual will be able to hail a ride through voice commands to a smart home hub. As the vehicle approaches, the individual's digital assistant will notify the individual to meet it outside. When the vehicle pulls up to meet the individual, it will unlock through an authentication with our smart watch. The car will have no driver; thus, the vehicle's AI will ask the individual to confirm the destination. While the vehicle starts driving, the video the individual was watching at home will come on screen and continue where the individual left it.

In this example, users' goal to get from location to location relies on their home's smart micro ecosystem, the digital assistant platform, the ecosystem and platform for the self-driving car (e.g., the car that the user owns or a car that belongs to a larger rideshare ecosystem), the manufacturer and operating system (OS) of their smart watch, their media-streaming service, and all the disparate infrastructures that seamlessly connect these micro ecosystems into a larger macro ecosystem. The entire experience in the example above relies on verbal commands, tactical interactions with various screens, and audio notification-based interactions. Designers who have skills in and mastery over all the components and control over each piece have to compose this symphony of connections. Further, an omnipresent backend conductor must also orchestrate this symphony.

To deliver the smart and connected service in the example above, designers will need to design for experiences they may not be able to fully control and balance users' needs with the ease of user interaction with these disparate systems. In addition to the need to control each piece in the system, developing such a cohesive experience requires new design skills and practices and a proverbial Rosetta Stone to translate subsystems' design language(s) and interaction with other subsystems into a seamless experience that a user can easily navigate to accomplish a task or goal.

3 New Form Factors and Interaction Methods

3.1 Introduction to Wearables

Wearables have existed since the turn of the 14th century, and they can be as simple as eyeglasses, which appeared around 1290 AD (Ilardi, 2007), or as complex as virtual-reality head gear or medical devices that provide brain stimulation. As such, we can broadly and simply define wearables as devices that one can wear on the body (Hiremath, Yang, & Mankodiya, 2014). Though seemingly simple, this broad definition creates challenges as wearables vary widely in both form factor and functionality. In this section, we explore various wearable examples and their interaction methodologies, their social challenges and adoption opportunities, research approaches to study them, and their practical implications.

Even though the first wearables (e.g., eyeglasses) have existed for centuries, many wearables experience adoption struggles. Indeed, most of the most egregious adoption hurdles concerns the social stigma around overt and unfamiliar forms. A survey of the current wearable form factors on the market shows that they tend to center around familiar form factors, such as watches, eyeglasses, and headphones (Mordor Intelligence, 2019). One can think about eyeglasses and watches as primitive wearables. Eyeglasses augmented eyesight in order to improve clarity. Watches provide ubiquitous time-related information to users.

Today, companies can piggyback on these wearables' long history and high social acceptability to create new wearables with better functionality and more value. Wrist-worn wearables now provide a wide range of functionality: they can provide biometric data (e.g., Fitbit) and GPS location (e.g., Garmin), regulate how individuals perceive body temperature (e.g., Embr Wave), and offer smartphone-based features (e.g., Apple Watch). The revolutionary Google Glass emerged in 2013 as technology that would provide hands-free, voice-enabled access to visual information through the familiar eyeglasses form factor. Despite its clear value proposition, Google Glass suffered from issues related to its form factor: its overt screen display and camera caused concern among users about privacy and surveillance (see Section 4 for further discussion).

Using a similar value proposition as Google Glass but with far fewer privacy or surveillance concerns, Bose Frames have successfully leveraged a familiar form factor to deliver audio and augmented reality without cameras, screens, or other overt forms. Other companies have also taken note about easing into familiar glasses form factors to provide smart and connected user experiences (e.g., Amazon Echo Frames).

Providing audio via glasses can not only increase user adoption by using a familiar form factor but also revolutionize headphones to become an all-day, everyday wearable that provides interactive audio experiences (Bose, 2019).

Traditionally, wearing headphones in public posed a social challenge. Wearing headphones in public situations can create unintended social isolation because others may perceive people wearing headphones as disengaged. Traditional headphones, which make it hard to hear conversations, can make it difficult to interact with others in social and service situations. Allowing users to connect with others and the environment while wearing headphones creates opportunities for designing enhanced experiences, such as the ability to carry conversations and/or hear a train announcement.

3.2 New Forms and Interaction Methods

To address social challenges that pertain to wearing headphones in service and social situations (e.g., being perceived as disengaged), companies have started to explore headphone form factors that individuals can wear all day while remaining accessible to the outside world and socially available to others. Companies such as Bose, Sony, and Aftershokz have started to explore new form factors altogether that leverage open-ear audio. An open-ear audio (OEA) design delivers music and audio content to the ear without blocking the ear; in other words, nothing goes in or on the ear. This design allows one to simultaneously consume personal audio content and listen to the outside world. Some examples include Sony Xperia Ear Duo, Aftershokz Aeropex, Bose Soundwear Companion, and Bose Frames. OEA design focuses on audio privacy; that is, providing audio in a way that people around the OEA user do not hear. One can leverage this concept to provide various novel experiences. For example, a recent study shows that using OEA to provide discreet feedback about food products' nutrition content not only provides a pleasant user experience but also helps people make healthier decisions (Jain & Djamasbi, 2019). The study provides evidence that the OEA concept can facilitate excellent research opportunities for designing novel products and developing new design theories.

Interaction modalities and hardware often co-evolve. Recently, we have seen many new interaction modalities that do not simply rely on touch-based interactions. Google has introduced hand-based gestures to its Google Pixel Phone via Project Soli (e.g., users can wave their hand right to left in front of the phone to track forward to the next song; Google, 2019). Hand-based gestures can provide easier access to product controls in a more discreet manner. Bose has implemented head-based gestures to its augmented reality platform. With head-based gestures, users can control a device and/or receive orientation-based information (e.g., Otocast). Countless other wearables and IoT devices use natural language (or voice) to interact with users and receive their input. However, many more interaction modalities beyond gesture and voice may arise in the future. For example, brain-computer interfaces that leverage neuroelectrical signals can offer interesting new modalities for delivering brain-control augmented reality (AR) wearables (Heater, 2019). By combining a wide range of interaction modalities with hardware that bridges the gap between the personal and the social, users can experience frictionless, all-day experiences without others perceiving them as disengaged or isolated. We discuss the impact that these ever-evolving form factors and interaction modalities may have on privacy and security issues in Section 4.

4 Privacy and Security

Users may lose privacy (which may also mean they lose security) when they adopt an ecosystem of connected smart hardware. Connected product experiences depend highly on the data that they collect about users, especially as these products learn and personalize their experience. Consequently, an overwhelmingly large amount of user data is collected over time in a connected ecosystem.

For example, listening to music in a connected product and service ecosystem no longer represents an intimately private experience. While listening to music in smart environments, users can expect to have (at least some of) the following data collected about them, such as the songs they played, their streaming device (e.g., computer, phone) and its operating system information (e.g., iOS 13.1.2.), their listening device (e.g., computer, headphones), their interactions with the song (e.g., paused, skipped), their mode of interaction (e.g., app, voice, headphone hardware), their location, and so on.

This data may allow a company (or partnering companies) to create a personalized experience. For example, using the data above, a company could trigger a user's workout playlist when it notices that the user begins to use headphones at a gym. We do not claim that anyone even looks at this data, especially at an individual user level. Rather, we note that an inherent conflict between personalization and privacy exists.

Many companies strive to develop products and services that users incorporate into their entire life. Amazon's Alexa exemplifies such a product/service that strives to provide real-time adaptive experiences for its users. To expand the boundary of its services from the home setting to outside the home environments, Amazon has created an array of on-the-go products such as Echo Buds, Echo Frames, and Echo Auto for the Alexa ecosystem. It also has developed partnerships with other companies (e.g., Bose, Garmin, etc.) to help expand its services' reach. As Alexa's ecosystem expands, so do the user data sets that make its personalized service experiences possible.

Further, privacy and security concerns do not always concern data that smart environments collect. For example, a major concern with open-ear products concerns audio leakage. As we mention above, the central value proposition behind open-ear concept concerns simultaneously connecting users to both their private content and the rest of their environment. Given the limitations in current open-ear technologies, users may lose privacy and/or security in ways that do not relate data collection in some situations. For example, with open-ear products, when one turns the volume to the highest, content leaks out (i.e., other people near the product can hear the content that it delivers to the ear). While such a leakage does not cause any harm from a privacy/security perspective in certain situations (e.g., when the user listens to music), such a content leakage can raise serious privacy/security concerns in other situations (e.g., when the user listens to confidential information).

Privacy concerns for connected technologies do not pertain only to consumer products such as open-ear headphones. As the healthcare industry uses more and more smart devices, privacy and security concerns expand to sensitive medical and biophysiological data, such as glucose levels, brain signals, heart rhythms, and so on. These types of smart ecosystems require even more consideration around privacy and security due to their implications for their users' health and safety.

Further, inadequate security in smart devices can cause damage beyond localized and private networks. Once compromised, one can weaponize smart devices to cause colossal damage to larger systems. For example, hackers conducted the 2016 distributed denial of service (DDoS) attack against domain name server (DNS) provider DYN via exploiting infected IoT devices from the Mirai botnet. By affecting the backbone of the Internet at large, this attack prohibited millions of Internet users from connecting to specific websites and Web services (Hilton, 2016; Lewis, 2017).

Despite an inherent trade-off between privacy and personalized experiences, organizations now design more and more smart systems in a way that reduces concerns around privacy and security. For example, Amazon requires all Alexa-enabled hardware products to have a microphone-mute function so that users have control over what they expose to Alexa. Google and Amazon prevent their devices from transmitting speech to the cloud prior to a wake-word that cues them to start listening (e.g. “Alexa” for Amazon devices or “OK Google” for Google devices). Amazon’s home security camera products have a privacy feature called “home mode” that stops recording when users are home. Similarly, to reduce privacy/security concerns, many location-based services allow users to enable location collection only while using the app versus all the time. Apple iOS notifies users occasionally about what applications or other entities track their location and provides easy-to-access security controls.

As the ecosystem of smart and connected devices expands, design thinkers must continually come up with innovative ways to carefully incorporate privacy and security controls into their designs particularly in situations with important trade-offs at stake (e.g., the user has to leave an app open in the background when they want their location used or forego more automatic experiences such as having their doors unlock when they arrive home). One way to achieve this goal involves paying closer attention to users’ privacy and security needs, such as through benchmarking studies that capture user perceptions of privacy and trust. As customer advocates, user researchers must probe and measure users’ concerns and requirements for privacy and security during any generative discovery work to ensure they integrate users’ needs in product definitions.

5 Conclusion

As companies develop new connected devices that take on new forms and include novel interaction modalities, we need to expand our current methods and practices to better understand how these devices can satisfy users’ needs and how they can address users’ security and privacy concerns.

By doing so, designers and researchers can develop new methodologies, best practices, and guidelines. In some cases, designers and researchers may have to start from scratch to answer research questions that require new understanding. Table 1 lists some research questions that can help designers and researchers develop novel smart products and services. Because answering these questions contribute both to UX theory and practice, we believe that collaboration between industry and academia can best address them.

Table 1. Sample Questions that Collaborations between Research and Industry can Best Address

• How should we best design for new interaction methods that may not be native or have haptic feedback? • How does skeuomorphism apply to gestures? • How can we design new interactions that feel native but are truly foreign? • How do we communicate new interaction designs and new forms’ value proposition? • What adoption barriers for new form factors and interaction models exist? And can we leverage existing mental models? • How might we evaluate augmented reality? • How should we measure trust and privacy concerns? • Can common UX research methodologies apply to smart and connected environments? • Can prototypes in lab settings be sufficient for testing ecosystem-based experiences (particularly those that have novel interactions)? • How might we create immersive experiences for testing?

Table 1 displays only a small fraction of issues that require extensive research. These issues, however, demonstrate that designers and researchers need to expand design thinking into systems thinking and evaluate how one can test ecosystem-level designs in a reliable and valid manner. We can attain such an extensive research effort only by tapping into business and market trends and applying critical rigor through research. By combining industry trends and challenges with academic research in decision making and user experience, we can increase the business value that we can create designing emerging experiences.

In addition to advanced theories and guidelines for creating value, continually developing seamless experiences requires a workforce that has training in designing for expanding smart ecosystems. As academia develop new approaches to design and embeds these approaches into their curriculum, they help industry in two critical ways: 1) to develop new talent (e.g., students graduating from UX degree programs) and 2) to upskill and improve the current workforce’s expertise (e.g., through UX certificate programs).

Through an integral partnership between academia and industry, we can effectively address complex research questions and, thus, develop successful IoT products and services. Through such a partnership, we can also effectively address the market need for a workforce that specializes in designing meaningful emerging experiences for users.

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John Wyatt is Co-founder and CEO of Adored WiFi (https://adoredwifi.com), John takes a data-driven approach to product development and user experience to create product market fit. An MBA graduate of Worcester Polytechnic Institute (WPI), his publications and conference presentations have centered around Augmented Reality, IoT, and the business value of UX. Contributing founder to the WPI UX and Decision Making (UXDM) Consortium, World Usability co-chair for UXPA Boston, and member of organizing committee for the annual UX Symposium (https://uxsym.org/), he is inspired by the creativity and innovation fostered through academic and industry partnerships.

Andy Piggott is SVP of Customer Success at Minim (https://www.minim.co), an IoT platform that enables and secures a better-connected home. As a recognized leader in the software-as-a-service and cloud industry, he has built teams and products with a relentless obsession toward customer and user experience. With a curious mind and a dangerous level of technical expertise, he is obsessed with blockchain, AI, and the IoT and uses his unique set of skills to build all sorts of interesting projects.

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